Model Uncertainty in the North American Rapid Refresh Ensemble: Multi-Physics vs. Stochastic Physics

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Introduction

The goal is to work toward the development and implementation of the hourly-updated North American Rapid Refresh Ensemble (NARRE) forecasting system. This system is planned for implementation during 2017, providing better probabilistic forecasts for aviation and other short-range applications. The work will be conducted collaboratively by the GSD/EMB model/assimilation development team with EMC.

In the first version of the system, model uncertainty will be addressed by using a mixed-dycore and mixed-physics (Table 1). Ultimately the goal is to switch to stochastic physics. Firstly, the focus is on cumulus treatment. The stochastically perturbed Grell-Freitas convective scheme ensemble is compared to a mixed-physics ensemble consisting of Kain-Fritsch (KF), Betts-Miller-Janjic (BMJ), Grell-Freitas (GF) and Arakawa-Schubert (AS) convective treatments. Preliminary results comparing the mixed-physics ensemble vs. the stochastic physics ensemble are presented.

Current Status of the NARRE System

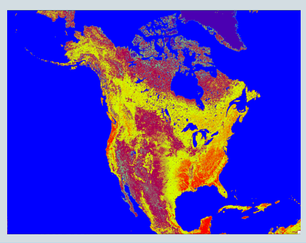
- RAP members include variations in physics (PBL, surface layer and convective treatment, as well as IC/ LBCs)
- NMMB members differ only in IC/LBCs

Member	Microphy.	Sfc.Lay.	PBL	Conve.	LBs
Ctl. rap	Thom.	MYNN	MYNN	Grell	GFS
rap1	Thom.	MOJ	MYJ	BMJ	GEFS1
rap2	Ferr.	MO	YSU	BMJ	GEFS2
rap3	Ferr.	MO	YSU	KF	GEFS3
nmmb	Ferr.	MOJ	MYJ	BMJ	GFS
nmmb1	Ferr.	MOJ	MYJ	BMJ	GEFS1
nmmb2	Ferr.	MOJ	MYJ	BMJ	GEFS2
nmmb3	Ferr	MOJ	MYJ	BMJ	GEFS3

Table 1. The mixed-physics, mixed-dycore NARRE configuration

Stochastic Physics Experiment Design

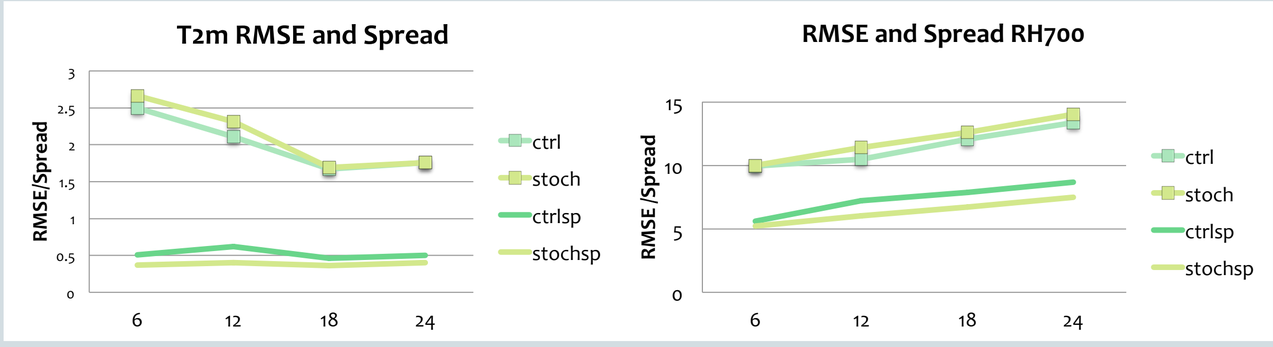
- First focusing on RAP (ARW) NARRE members only
- Starting with convective treatment
- The mixed-physics ensemble consists of 4 members using KF, BMJ, GF and AS convective treatments
- Stochastic GF ensemble consists of 4 members with stochastically perturbed closures
- 2-week period: May 15-31, 2013



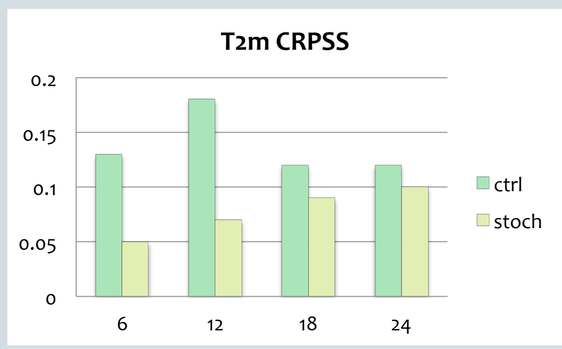
Domain of integration

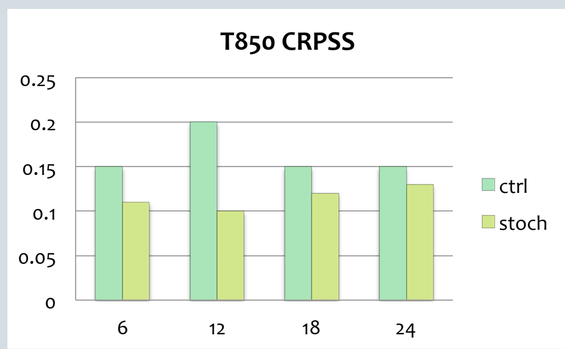
Preliminary Results

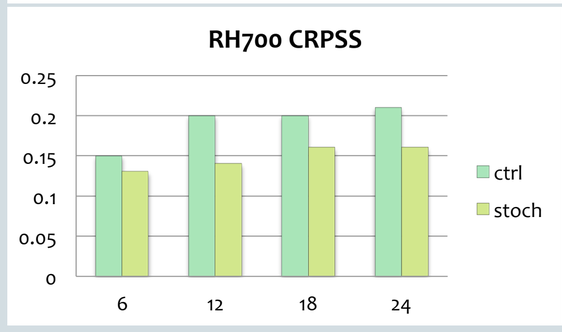
The ensemble mean RMSE and spread are evaluated for different variables. Examples for 2-m temperature and 700 mb relative humidity are presented.



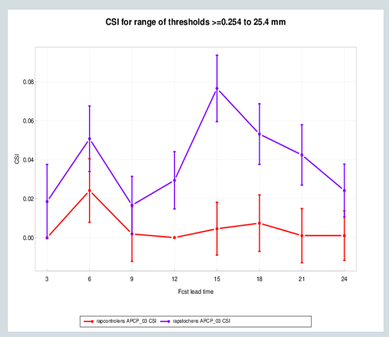
The Continuous Rank Probability Skill Score (CRPSS) for different variables was also evaluated. Examples for 2-m temperature, 850 mb temperature and 700 mb relative humidity are presented.

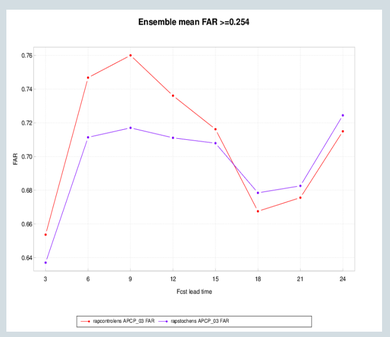


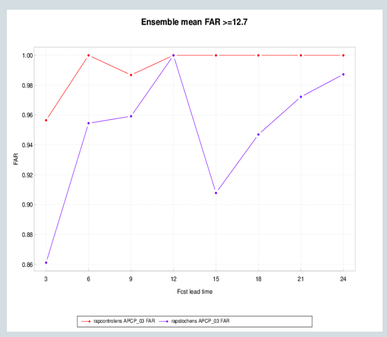


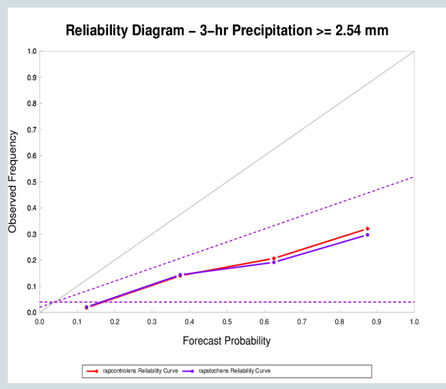


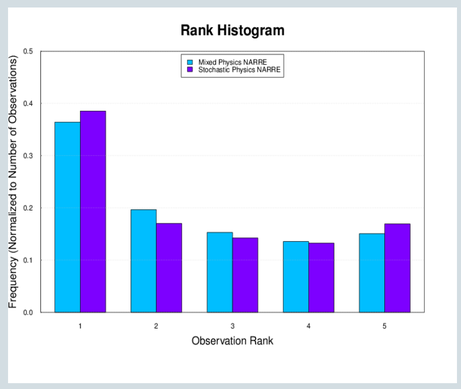
For precipitation verification, both deterministic (ensemble mean) and probabilistic performance were evaluated.











- RMSE, Spread and CRPSS slightly better for the mixed-physics ensemble
- CRPSS of the stochastic ensemble seems to improve with the lead time
- Precipitation evaluation reveals better performance of the stochastic ensemble mean
- Precipitation probabilistic evaluation indicates very similar results between the ensembles.

Outlook

The next step will be performing many more experiments that include sensitivity to stochastic perturbation parameters (e.g., spatial de-correlation length and magnitude) as well as various options for stochastic parameter perturbations within the GF scheme (e.g., adding stochastic perturbations to the entrainment rate)

Collaborators

- NOAA/ESRL/GSD
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